IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Sergei F. Burlatsky
Serial No.:	10/808,151
Filed:	March 24, 2004
Group Art Unit:	1724
Examiner:	Hopkins, Robert A.
Title:	FUEL DEOXYGENATION SYSTEM

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION UNDER RULE 1.131

I, David L. Wisz, state as follows:

1) I am a patent attorney, at all times representing the Applicant in this application, and responsible for its preparation and filing.

2) I have reviewed the disclosure documents and correspondence with the client concerning this application in preparing this Declaration.

3) The invention disclosure was prepared by the inventors on a date before the effective 35 U.S.C. 102(e) date of *Staroselsky*, which is December 12, 2003. Exhibit A attached to this Declaration is a copy of an invention disclosure document that was completed prior to December 12, 2003. Dates have been redacted, but I have reviewed the dates and all are prior to December 12, 2003.

4) I have also corresponded with the inventors prior to the effective date of the *Staroselsky* reference. Exhibit B attached to this Declaration is a copy of an email prior to the effective date of the *Staroselsky* reference. The date has been redacted, but I have reviewed this email and it is prior to December 12, 2003.

5) I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Dated: July ____, 2006

David L. Wisz

EXHIBIT A

Ted Olds

Pratt & Whitney

Legal Department - Intellectual Property
Outside Counsel Information Package.

-021

- **PW Docket Number:** EH-11107 **Date:**
- **Lawpack Number:** PWA017617

- **Government Rights Notice:** ☐ Yes ☒ No
  Agency: None
  Contract Number:

- **Potential §102 Statutory Bar:** ☐ Yes ☒ No
  Target Filing Date:

- **Rationale for Patenting:**

- **PW Contacts:**

	Name:	*Phone: / Fax:*
Attorney/Agent:	John Swiatocha	(860) 565-5106 / (860) 565-9276
Paralegal:	Karen Malatesta	(860) 565-3499 / (860) 565-9276

- **General Instructions:**
  - Provide an e-mail with attachments for application as filed including drawings to the Attorney at: ~~swiatojo@pweh.com~~ and to: turleyks@pweh.com . john.swiatocha@pw.utc.com
  - When sending the draft application to the inventors for review, also send a copy to the Attorney.
  - Reference both the Docket number and Lawpack number on all invoices.

- **Special Instructions:**
  -

Privileged Attorney / Client Communication

Pratt & Whitney
Proprietary

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Legal Department - Intellectual Property
Outside Counsel Information Package.

- **Technical Contacts:**

	(Primary) Inventor 1:	*Inventor 2:*
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Plant	East Hartford	East Hartford

	Inventor 3:	*Inventor 4:*
Name		
Email		
Phone		
Plant		

	Inventor 5:	*Inventor 6:*
Name		
Email		
Phone		
Plant		

For more than (6) inventors use a second sheet.

Privileged Attorney / Client Communication

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DeOxygenation of fuel using a porous membrane and a sweep gas for improved performance

Background

The advantages of stabilizing fuel by deoxygenation are many-fold. An outstanding benefit is that the fuel can be heated to very high temperature (+800F) without coking, enabling overall better energy integration, improving the performance. This information has been documented in other disclosures and patents.

A method to enable deoxygenation is by using a non-porous membrane that selectively removes oxygen from the fuel stream. In prior art, the fuel is pressurized on one side of the non-porous membrane while maintaining vacuum on the other side. This pressure differential translates to oxygen concentration differential across the membrane, enabling diffusion of Oxygen through the membrane. In these systems, the membrane is very thin (~2-4 microns) and lacks mechanical integrity, hence is supported by a porous backing.

Ultra thin membranes (2-5 microns) often have defects and pin-holes. This results in fuel seeping through the membrane and accumulating in the backing layer. This adds an additional resistance to the deoxygenation and is the dominant resistance at long times.

Invention

We propose a new method to deoxygenate the fuel, by using [redacted] Additionally, instead of using vacuum as indicated in prior art, sweep gas (eg. N_2) is proposed to maintain [redacted] across the membrane (see Fig. 1 and 2). In this method, the flux of oxygen through the membrane is proportional to the diffusivity of oxygen in the sweep gas, and is given as

$$j_{O_2}^{porous} = \frac{D_{O2}\varepsilon_m}{\tau L_m}\left(\frac{C_{O2}^f}{H_{fuel-N2}}\right)Zb.$$

$$H_{fuel-N2}$$

While, in prior art the flux of oxygen is proportional to the diffusivity of oxygen in the non-porous membrane (D_m).

$$j_{O_2}^{non-porous} = \frac{D_m}{L_m'}\left(\frac{C_{O2}^f}{H_{fuel-membrane}}\right)Zb.$$

Here, L_m' $H_{fuel-membrane}$

The potential improvement in deoxygenation performance, in a case when transport through the membrane is limiting is

$$\frac{\frac{D_{O2}\varepsilon_m}{\tau L_m H_{fuel-N2}}}{\frac{D_m}{L'_m H_{fuel-membrane}}} \sim 100.$$

Diffusion coefficient of oxygen in the membrane is more than 3 orders magnitude lower than that of the diffusion coefficient of oxygen in a sweep gas like N_2. However, in the current proposal, the porous membrane would have an order of magnitude higher thickness than the non-porous membrane. The ratio of the distribution coefficients $H_{fuel-N2}/H_{fuel-membrane}$ is typically less than 1, indicating an improvement in performance with the porous membrane.

Since, the pores are much larger, one can envision fuel leakage through the macro pores. [redacted] r_p. In order to keep nitrogen from bubbling through the pores into the fuel, the pressure on the sweep gas side has to be lower than the pressure on the fuel side.

$$0 \le \Delta P \le \frac{2\sigma Cos\theta}{r_p}$$

In the counter flow configuration, the maximum pressure differential across the porous membrane is at the entrance of the fuel. Hence, ensuring that the fuel meniscus in the largest membrane pore is in place at the entrance of the reactor will ensure no leakage of the fuel into the sweep gas.
Therefore,

$$P_{f,in} - P_{s,out} \le \frac{2\sigma Cos\theta}{r_p}$$

At room temperature, the surface tension σ of kerosene is 25 dynes/cm or 0.025 Nm^{-1}. The contact angle θ is ~140° * for JP-8 on Teflon AF-2400 membrane, and for a maximum pore radius of r_p of 1 micron, a pressure differential of 10 kPa can keep the fuel from leaking to the swe

* Personal communication with Harry Cordatos

Figures

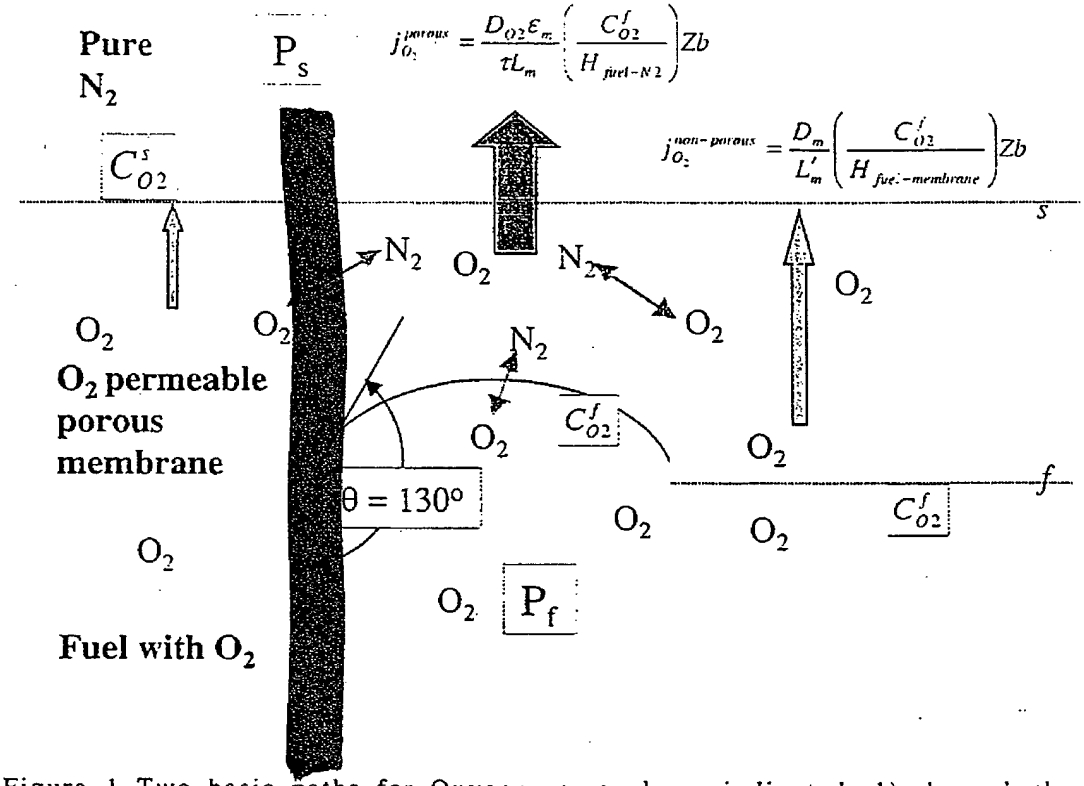

Figure 1 Two basic paths for Oxygen removal are indicated. 1) through the membrane-sweep gas interface and 2) through fuel-sweep gas interface. Normally, the latter is the least resistance path. Here, P is the pressure. The subscripts s refers to sweep gas, f to the fuel, in to the flow inlet and out to the flow outlet. C_{O2} is the Oxygen concentration in the fuel. D_{O2} is the diffusion coefficient of oxygen in the sweep gas, L is the thickness of the channel/layer, Z is the length of the channel, b is the width of the channel, and H is the thermodynamic distribution coefficient.

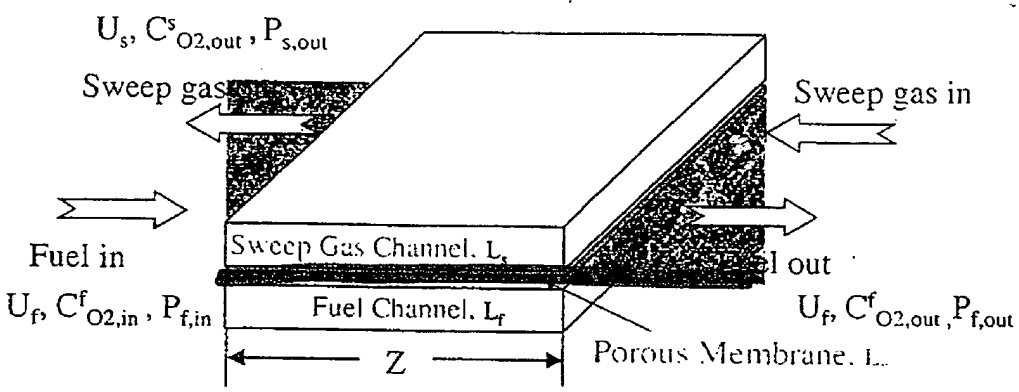

Figure 2: The configuration of the deoxygenator unit, showing the fuel and sweep gas flow channels, separated by the porous membrane. [redacted]. Here, U is the velocity, C_{O2} is the Oxygen concentration in the fuel, L is the thickness of the channel/layer, Z is the length of the channel and P is the pressure. The subscripts or superscripts, s refers to sweep gas, f to the fuel, in to flow inlet, out to the flow outlet, and m to the membrane.

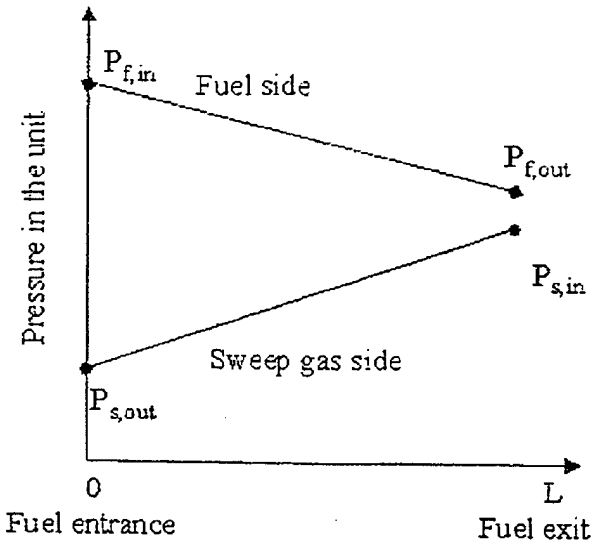

Figure 3 The pressure profiles along the length of the deoxygenator depicting the maximum pressure gradient across the membrane at the region of the fuel entrance. Here, P is the pressure. The subscripts s refers to sweep gas, f to the fuel, in to the flow inlet and out to the flow outlet.

EXHIBIT B

Beard, Beth

From: Beard, Beth
Sent:
To: 'burlatsf@utrc.utc.com'; 'gummalm@utrc.utc.com'
Subject: FW: Patent application; EH-11107; our file 67,097-021

Importance: High

It has been almost a month since we sent the application to you. Please let me know the status of this matter.

Thanks!!

Beth A. Beard
Assistant to David L. Wisz
Carlson, Gaskey & Olds, P.C.
400 West Maple Road
Suite 350
Birmingham, MI 48009
Direct Dial (248) 988-8697

-----Original Message-----
From: Beard, Beth
Sent:
To: 'burlatsf@utrc.utc.com'; 'gummalm@utrc.utc.com'
Cc: 'john.swiatocha@pw.utc.com'; Wisz, David
Subject: Patent application; EH-11107; our file 67,097-021

Re: Fuel Deoxygenation System

Attached for your review is a draft of the above-identified patent application and informal drawings to expedite the review process.

Please carefully review the application as soon as possible for accuracy and completeness. Keep in mind that we must disclose the best mode known for practicing the invention at the time of filing. Under the law, the best mode must further be disclosed in a way that would enable one of ordinary skill in the art to practice the invention without undue experimentation.

Also enclosed is a Declaration and Assignment for your execution. If the application meets with your approval, please **sign** and **date** the Declaration and Assignment and return these papers to our office as soon as possible for filing with the United States Patent and Trademark Office. If any changes are made to the Assignment or Declaration, please be sure to initial your handwritten changes. If the application requires any revisions, please retain the Declaration and Assignment unsigned and contact me at your earliest convenience so that I can incorporate any changes that you feel are necessary.

Best Regards,

David L. Wisz
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Informal drawings.pdf


Declaration (Utility) PTO-SB-0...


Assignment.doc